Dental and Cranial Evidence on the Affinities of the East Asian and Pacific Populations

Tsunehiko Hanihara

Department of Anatomy, Jichi Medical School

Tochigi, Japan

Present Address: Department of Anatomy
Sapporo Medical College
Sapporo, Japan

Introduction

During the period from the beginnig of the Aeneolithic Yayoi age (ca. 300 B.C.) to the early historic age (ca. A.D. 700) the people adapted to the cold climate in Northeast Asia migrated to the western part of the Japanese Archipelago (Hanihara. K., 1987, 1991). Skeletal remains excavated from the Doigahama site at the western end of Honshu and those from the Kanenokuma site in north Kyushu are, for instance, recognized to be the typical representatives of the Yayoi populations and they resemble a majority of modern Japanese (Yamaguchi, 1982, 1985; Hanihara, K., 1985, 1987: Dodo and Ishida, 1988, 1990; Mizoguchi, 1988; Nakahashi, 1989).

Some investigators thought that the Neolithic Jomon population were different from the present-day Japanese, the former having been replaced by the ancestral population of the latter (Howells, 1973; Brace and Nagai, 1982; Brace et al., 1989). However, geographically isolated Japanese such as Ainu in Hokkaido and the Aogashima, Tokunoshima, and Okinawa islanders generally maintain some conservative characteristics which may have been inherited from the Neolithic Jomon population (Hanihara, T., 1989a, b, c). Clinal changes from southwest to northeast Japan in somatometric characters, gene frequencies of several traits, cranial variation, etc. are also demonstrated (Hanihara, K. et al., 1982; Kouchi, 1983; Omoto, 1987). These variations are likely derived from difference between the Neolithic Jomon and the Aeneolithic Yayoi populations.

Geographic variations in physical characteristics of modern Japanese indicate that the Neolithic Jomon people played an important role in the formation processes of modern Japanese. To find the Jomon elements which are still maintained in modern Japanese may, therefore, constitute a major problem in the formation history of modern Japanese.

The earliest human occupation of the Japanese Archipelago is closely associated with the spread and northern extension of the populations whose homeland is supposed to be somewhere in the mainland Southeast Asia or in the landmass of the continental shelf called Sundaland in the late Pleistocene period when sea level was much lower than it is today (Macintosh and Larnach, 1976; Brues, 1977; Turner, 1976, 1979, 1987, 1989; Turner and Swindler, 1978; Omoto, 1984; Bellwood, 1985).

Sundaland is generally thought to have been a geogenetic center from which all the Oceanic populations have radiated (Riesenfeld, 1956; Simmons, 1956, 1962; Bowler, 1976; Chappell, 1976; Howells, 1976; Turner, 1976, 1979, 1987; Birdsell, 1977; Brace and Hinton, 1981; Bellwood, 1985). The first migration into Oceania from this center was possibly taken place by Proto-Australoids about 40, 000-50, 000 years ago, and they formed the Australo-Melanesian lineage (Bowler, 1976; Howells, 1976; Thorne, 1976; Birdsell, 1977; Brace and Hinton, 1981; Omoto, 1984). In the tropical rain-forest of Sundaland, the ancestral Proto-Australoids may have evolved into the aboriginal populations of Southeast Asia from which Negritos of Luzon, the Philippines, derived (Omoto, 1984; Hanihara, T., 1989c, 1990a, b, c, in press). The final migration to the Pacific was taken place in the Holocene by the Austronesian speaking peoples, the lineages leading to Polynesians and Micronesians of today (Riesenfeld, 1956; Simmons, 1962; Harris, et al., 1975; Brace and Hinton, 1981, Kirch, et al., 1989; Turner, 1989).

In the analyses of the affinities between indigenous Japanese, or those of the Jomon lineage, and the Pacific populations, I attached great importance to the physical characteristics of the Aeta tribe of the Philippine Negritos (Hanihara, T., 1989c, 1990a, b, c, in press). They are thought to be the remnants which maintain some archaic characters. Some investigators emphasize the greater degree of Australoid inheritance in their physical characteristics (Birdsell, 1949, 1977; Garn, 1961; Coon, 1962; Jacob, 1967; Howells, 1976; Brues, 1977; Kennedy, 1977; Glinka, 1981; Bellwood, 1985). Recent studies suggest, on the other hand, that this population may have been influenced by the hunter-gatherers from the Asian mainland culturally as well as physically (Omoto, 1984). From dental and cranial anthropological viewpoints, the aboriginal populations of Southeast Asia, Negritos of the Philippines and Dajaks of Borneo, may have shared the same ancestral stock with the Asian-Pacific populations (Hanihara, T., 1989c, 1990a, b, c, in press).

Taking these racial diversifications into consideration, the origin of modern Japanese may be assessed through comparative studies on the Asian and the Pacific populations. From this viewpoint, the present study compares Japanese in the past and present with the major geographical populations including Australo-Melanesians, Polynesians, Micronesians, East and Southeast Asians, for the purpose of reconstructing the possible origins of indigenous inhabitant of the Japanese Archipelago.

Dental characteristics provide one of the most reliable information for reconstructing population history (Turner, 1989). I would like to present, therefore, the results obtained from metric and non-metric dental traits in regard to not only the origin and affinities of the Neolithic Jomon population and the present-day Japanese but also the reconstruction of the population diversification model of East Asia and the Pacific. Cranial measurements are, at the same time, taken into consideration together with the dental data.

Materials and Methods

The information of samples used in the dental analyses was given in Table 1 together with their approximate location (Map 1, 2). The basic statistical data of these samples were already given (Hanihara, T., 1989a, b, c, 1990a, b, c, in press). Table 2 provides similar information for the materials used in the cranial analyses. Concerning the metric traits in both dentition and cranium, only complete or substantially complete male samples were measured, while male and female samples were combined for non-metric traits because between-sex differences in frequencies were insignificant in most of the samples observed.

The criteria for classification of non-metric tooth crown characters have been outlined elsewhere (Hanihara, T., 1990b, in press). As regards the classification of the extent of shoveling in the maxillary central incisors, the teeth with the lingual fossa less than 0. 5mm depth were classified into 'no shovel' (-), those deeper than 0. 5mm and less than 1. 0mm into 'moderate' (+), and those deeper than 1. 0mm into 'strong' (++).

Table 1. Materials used in the dental analysis.

Population	Collection of	Provenance
Japanese	Univ. of Tokyo, Jichi Medical School	Main-island Japanese (recent)
Ainu 1	Univ. of Tokyo Sapporo Medical College	Central and eastern Hokkaido (recent)
Ainu 2	Univ. of Tokyo Sapporo Medical College	Southwest Hokkaido (recent)
Aogashima	Univ. of Tokyo	(recent)
Okinawa	Univ. of Tokyo, Kyoto Univ.	(recent)
Tokunoshima	Kagoshima Univ.	(recent)
Nansei	Univ. of Tokyo, Kyoto Univ. etc.	Nansei Islands (recent): Tanegashima, Amami-Oshima Kikai-, Okinoerabu-, Yoro-, Yoron-, Miyako-, Ishigaki-, Hateruma-, Yonaguni-Island
Jomon	Univ. of Tokyo	Kanto district (5,600~2,300 B.P.)
Yayoi 1	Kyushu Univ.	Doigahama site, Yamaguchi Pref. (2,300~1,700 B.P.)
Yayoi 2	Kyushu Univ.	Kanenokuma site, Fukuoka Pref. Mitsu site, Saga Pref. (2,300~1,700 B.P.)
Hirota	Kyushu Univ.	Hirota site, Tanegashima, (2,300 ~ 1,700 B.P.) Kagoshima Pref. Yayoi period
Chinese	Univ. of Tokyo, Kyoto Univ.	Manchuria (recent)
Negrito	Univ. of Tokyo	Aeta tribe, Bataan Peninsula, The Philippines (recent)
Dajak	Univ. of Tokyo, Kyoto Univ.	Pontianak, Kapuas River, Borneo (recent)
Micronesian	Bishop Museum	Guam, Mariana (pre-Spanish)
Polynesian	Bishop Museum	Mokapu site, Oahu, Hawaii (400 ~ 500 B.P.) Marquesas, Uahuka (2,000~1,700 B.P.)
Melanesian	Bishop Museum, Univ. of Tokyo	Fiji, New-Hebrides, New Guinea, etc. (recent)
Australian Aborigines	Univ. of Tokyo, etc.	Western Australia (recent)

Metric and Non-metric data were recorded from the right side teeth. When a particular tooth was missing or badly damaged on the right side, the corresponding left side tooth was measured and/or observed. In dental measurements, mesiodistal crown diameters were measured except for maxillary and mandibular third molars.

Initially, 31 standard cranial measurements were recorded in each specimen. A majority of items measured were those described by Martin and Sellar (1957). In the present study, the following 12 items were selected: maximum cranial length (M1); cranial base length (M5); maximum cranial breadth (M8); minimum frontal breadth (M9); basion-bregma height (M17); bizygomatic breadth (M45); middle facial breadth (M46); upper facial height (M48); orbital length, left (M51); orbital height, left (M52); nasal breadth (M54); and nasal height (M55).

Table 2. Materials used in the cranial analysis (male).

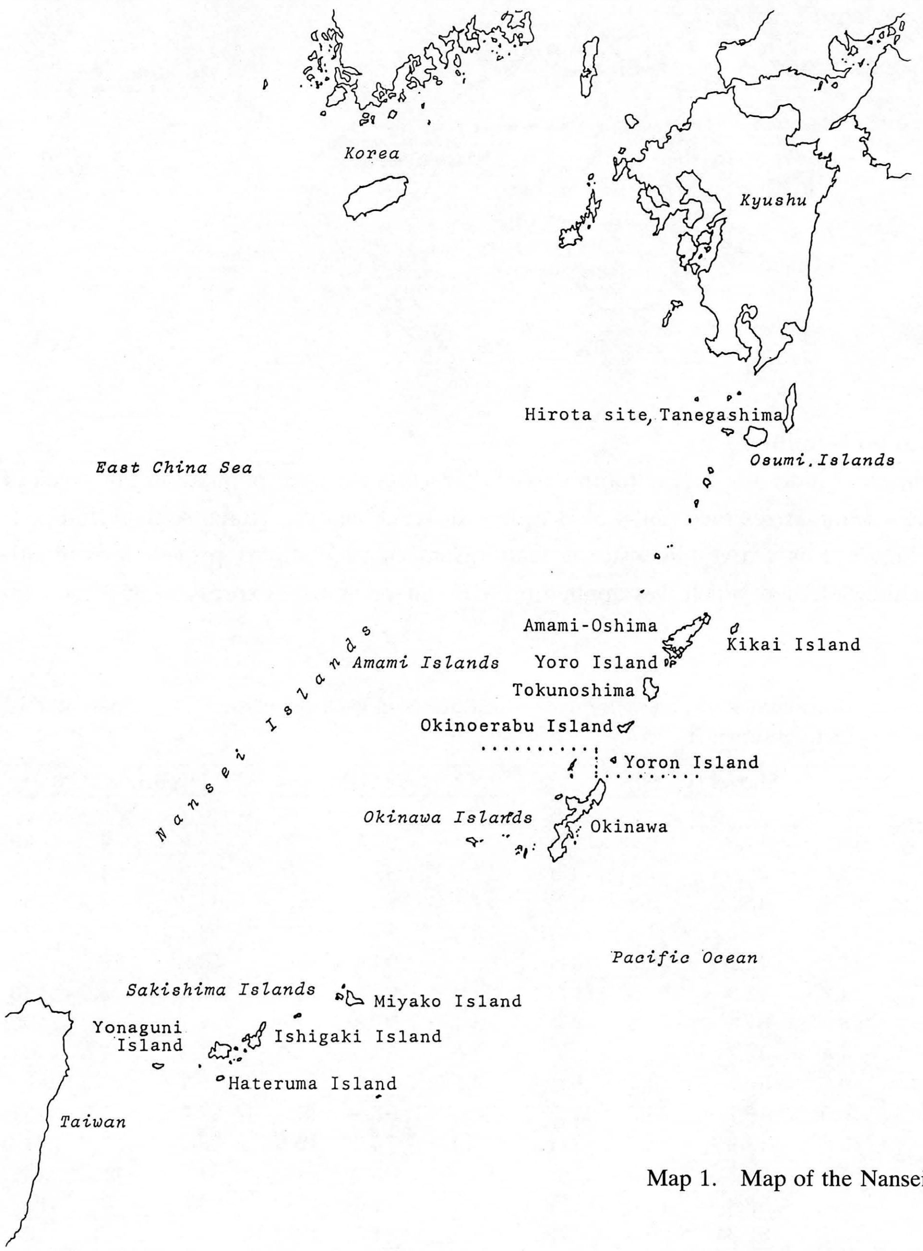
Population	N	Author	Provenance
Japanese 1	88	Present study	Main-island east Japan (recent)
Japanese 2	30	Present study	Main-island west Japan (recent)

Ainu 1	38	Present study	Central and east Hokkaido (recent)
Ainu 2	36	Present study	South and west Hokkaido (recent)
Amami 1	49	Present study	Tanegashima, Amami-Oshima (recent)
Amami 2	21	Present study	Kikai Island (recent)
Amami 3	24	Present study	Tokunoshima, Yoro-, and Okinoerabu-Island (recent)
Okinawa	24	Present study	Okinawa Island (recent)
Sakishima	24	Present study	Miyako-, Yonaguni-, Hateruma-, and Ishigaki-Island (recent)
Jomon 1	61	Present study	West Japan (4,500∼2,300 B.P.)
Jomon 2	32	Present study	East Japan (5,600∼2,300 B.P.)
Yayoi	112	Dept. Anatomy II Kyushu Univ. (ed.)	West Japan, western-end of Honshu and northern part of Kyushu (2,300 ∼ 1,700 B.P.)
Hirota	23	Dept. Anatomy II Kyushu Univ. (ed.)	Hirota site, Tanegashima Island, Kagoshima Pref. Yayoi period (2,300∼1,700 B.P.)
Minatogawa	1	Suzuki (1982)	Minatogawa I (Ca. 17,000 B.P.)
Chinese 1	71	Present study	Manchuria, Liaoning Pref. (recent)
Chinese 2	26	Present study	Manchuria, Kirin Pref. (recent)
Liukiang	1	Woo (1959)	(Ca. 18,000 B.P.)
Korean	36	Present study	(recent)
Formosa	13	Present study	Including Atayal tribe (recent)
Dajak 1	11	Present study	Pontianak, Kapuas River, Borneo (recent)
Dajak 2	41	Bonin (1931)	Borneo
Negrito	33	Bonin (1931)	Aeta, Philippines
Aadamanese	24	Bonin (1931)	Negrito of Andaman Island
Java 1	30	Bonin (1931)	Central Java
Java 2	21	Bonin (1931)	East Java, Madura
Java 3	55	Bonin (1931)	West Java, Batavia and Bantam
Southeast Asia		Pietrusewsky (1984)	
Sulu	38		
L-Sundas	44		Lesser Sundas
Borneo-Celebes	76		
SE-Asia	86		Mainland Southeast Asia: Vietnam, Laos, Cambodia, Thailand and Burma
Melanesia		Pietrusewsky (1984)	
Mysore-Rubi	48		New Guinea
Sepib River	67		New Guinea
Purari Delta	71		New Guinea
New-Britain	85		
New-Ireland	53		
New-Hebrids	84		
New-Caledonia	85		
Fiji	32		
Australian Aborigine		Pietrusewsky (1984)	
N-Territory	62		Northern Territory
N-Queensland	34		Northern Queensland
S-Queensland	74		Southern Queensland
Coastal-NSW	62		Coastal New South Wales
Murray-R	21		Murray River
Swanport	36		
S-Australia	52		South Australia
W-Australia	18		Western Australia

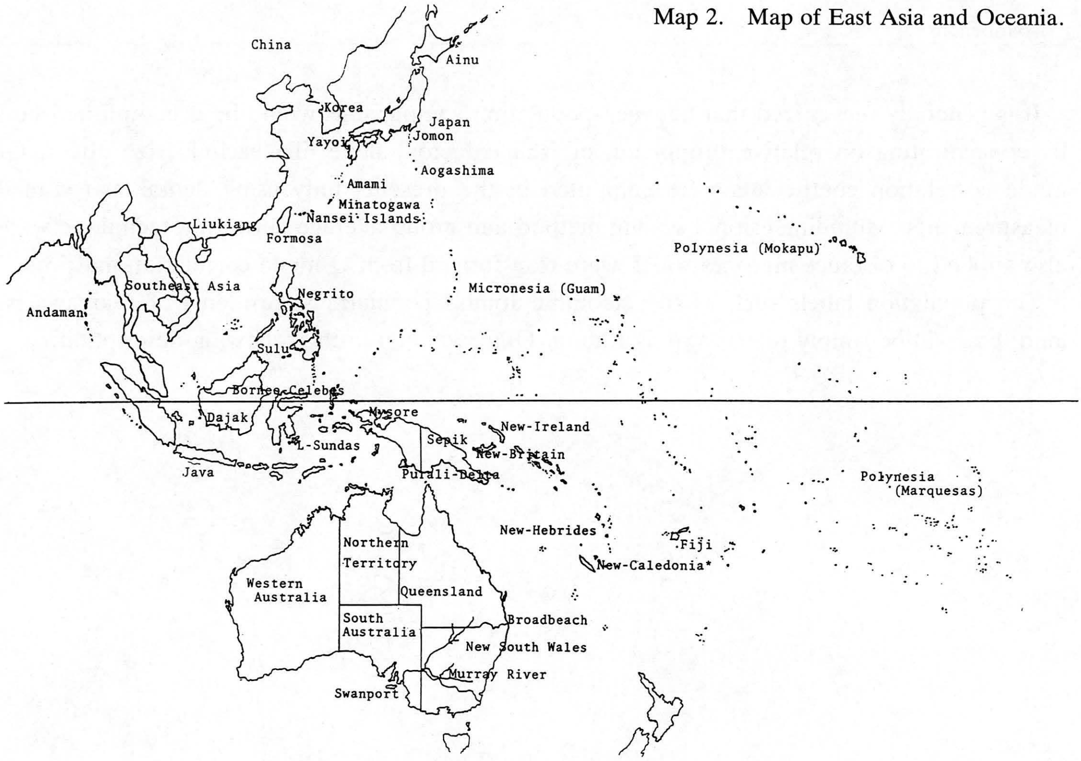
Broadbeach	17

It is generally recognized that between-population comparisons would be accomplished best by concentrating on relative proportion or 'shape factor' alone. To exclude size effect, Q-mode correlation coefficients were computed in the present study using dental and cranial measurements. Multidimensional scaling method and group average clustering technique were also applied to distance matrices which were transformed from Q-mode correlation matrices.

The population labels such as the Neolithic Jomon populations, residents of Okinawa island, etc. will be simply referred to as Jomon, Okinawa, etc. in the following description.



Map 1. Map of the Nansei Island chain.



Map 2. Map of East Asia and Oceania.

Analyses Based on Dentition

The frequencies of nine non-metric tooth crown characters for each population are given in Table 3. Table 4 summarizes the results of B-square distance analysis (Balakrishnan and Sanghvi, 1968). Figure 1 is a two-dimensional scattergram of populations provided by multi-dimensional scaling method which was applied on a B-square matrix, expressing 85% of total variance.

Table 3. Frequency distributions of non-metric crown characters in each population (in %, parenthesis; number of teeth observed.)

Population	Shovel (UI 1)				Carabelli (UM 1)			Hypocone (UM 2)		
	++	+	−		+	−		+	−	
Japanese	49.5	41.3	9.2	(109)	6.5	93.5	(72)	95.9	4.1	(49)
Chinese	63.0	29.6	7.4	(27)	17.5	82.5	(80)	95.3	4.7	(49)
Yayoi 1	57.1	33.3	9.8	(42)	14.5	85.5	(62)	84.3	15.7	(51)
Yayoi 2	47.5	45.0	7.5	(40)	12.2	87.8	(41)	95.8	4.2	(23)
Jomon	17.3	43.2	39.5	(81)	5.0	95.0	(101)	73.9	26.1	(111)
Ainu 1	24.8	41.9	33.3	(117)	8.0	92.0	(150)	65.0	35.0	(120)
Ainu 2	13.5	67.6	45.9	(37)	2.2	97.8	(90)	76.7	23.3	(90)
Hirota	4.4	52.2	43.4	(23)	13.0	87.0	(23)	87.5	12.5	(24)
Okinawa	40.6	50.0	9.4	(64)	9.1	90.9	(66)	79.7	20.3	(59)
Nansei	20.0	46.7	33.3	(15)	4.5	95.5	(89)	87.7	12.3	(81)
Negrito	23.8	42.9	33.3	(21)	25.0	75.0	(20)	88.2	11.8	(17)
Micronesia	16.9	54.2	28.8	(59)	16.7	83.3	(90)	81.7	18.3	(82)
Polynesia	16.5	68.5	15.0	(127)	18.4	81.6	(179)	90.8	9.2	(152)
Australia	11.1	59.3	29.6	(27)	18.5	81.5	(27)	96.3	3.7	(27)

6 th cusp (LM 1)			7 th cusp (LM 1)			Defl. Wrink. (LM 1)			Dist. tri. crest. (LM 1)		
+	−		+	−		+	−		+	−	
42.6	57.4	(342)	4.3	95.7	(342)	30.7	69.3	(342)	12.0	88.0	(342)
32.7	67.3	(52)	4.7	95.3	(64)	45.2	54.8	(42)	23.3	76.7	(43)
41.5	58.5	(53)	4.2	95.8	(72)	41.3	58.7	(46)	14.0	86.0	(50)
47.6	52.4	(42)	4.3	95.7	(47)	48.6	51.4	(35)	21.6	78.4	(37)
42.9	57.1	(119)	9.2	90.8	(131)	27.6	72.4	(87)	4.3	95.7	(93)
17.9	82.1	(140)	2.1	97.9	(146)	17.5	82.5	(137)	5.9	94.1	(136)
20.9	79.1	(86)	6.7	93.3	(90)	17.6	82.4	(68)	15.0	85.0	(80)
27.8	72.2	(36)	5.4	94.6	(37)	6.1	93.9	(33)	0.0	100.0	(34)
20.3	79.7	(64)	3.1	96.9	(64)	29.7	70.3	(64)	1.6	98.4	(63)
19.3	80.7	(119)	3.8	96.2	(133)	25.4	74.6	(114)	14.0	86.0	(114)
17.7	82.3	(17)	11.8	88.2	(17)	17.7	82.3	(17)	5.9	94.1	(17)
34.9	65.1	(106)	6.3	93.7	(111)	46.7	53.3	(105)	6.4	93.6	(101)
43.2	56.8	(132)	6.9	93.1	(144)	37.3	62.7	(118)	13.7	86.3	(131)
40.4	60.0	(25)	11.1	88.9	(24)	38.1	61.9	(21)	4.8	95.2	(21)

Protostylid (LM 1)			4 cusp pattern (LM 2)		
+	−		+	−	
6.6	93.4	(425)	26.0	74.0	(96)
7.5	92.5	(53)	15.6	84.4	(64)
9.4	90.6	(64)	12.5	85.7	(56)
8.7	91.3	(46)	18.5	81.5	(27)
4.2	95.8	(96)	37.6	62.4	(133)
5.2	94.8	(135)	60.2	39.8	(113)
2.4	97.6	(82)	52.3	47.7	(86)
5.6	94.4	(36)	43.6	56.4	(39)
10.9	89.1	(64)	57.6	42.4	(59)
5.0	95.0	(121)	34.0	66.0	(106)
5.9	94.1	(17)	58.8	41.2	(17)
12.9	87.1	(93)	24.7	75.3	(94)
7.3	92.7	(138)	45.8	54.2	(142)
4.4	95.6	(23)	18.5	81.5	(27)

Table 4. B-square distance matrix based on nine non-metric crown characters.

Population	Jpn	Chi	Ya 1	Ya 2	Jom	Ai 1	Ai 2	Hrt	Oki	Nan	Neg	Mic	Pol	Aus
Japanese	—													
Chinaese	0.626	—												
Yayoi 1	0.387	0.276	—											
Yayoi 2	0.346	0.382	0.340	—										
Jomon	1.139	2.628	1.681	1.735	—									
Ainu 1	2.047	3.437	2.657	3.043	0.793	—								
Ainu 2	1.992	3.674	3.064	2.709	0.795	0.669	—							
Hirota	1.983	3.918	3.094	3.004	0.740	0.989	0.745	—						
Okinawa	1.137	2.269	1.722	1.937	0.949	0.486	1.017	1.243	—					
Nansei	0.858	1.910	1.556	1.373	0.589	0.861	0.524	0.704	0.806	—				
Negrito	1.804	2.815	2.536	2.579	1.175	0.907	1.145	0.739	0.785	0.973	—			
Micronesian	1.182	1.979	1.285	1.111	0.672	1.672	1.447	1.268	1.185	0.767	1.426	—		
Polynesian	1.306	2.473	2.035	1.331	0.877	1.672	0.917	1.042	1.200	0.848	1.050	0.547	—	
Australian	1.317	2.390	1.835	1.374	0.942	2.520	1.678	1.103	1.965	0.967	1.506	0.428	0.566	—

It is easily recognized that modern Japanese is closely related to the Yayoi samples and Chinese from the northeastern part of China (Manchuria). Jomon, Ainu and Nansei islanders including Okinawa form another group, showing close affinities to Micronesians, Polynesians, and Negritos but not to the Australian Aborigines. The findings presented in Fig. 1 support the dual structure model for the population history of Japanese proposed by K. Hanihara (1991).

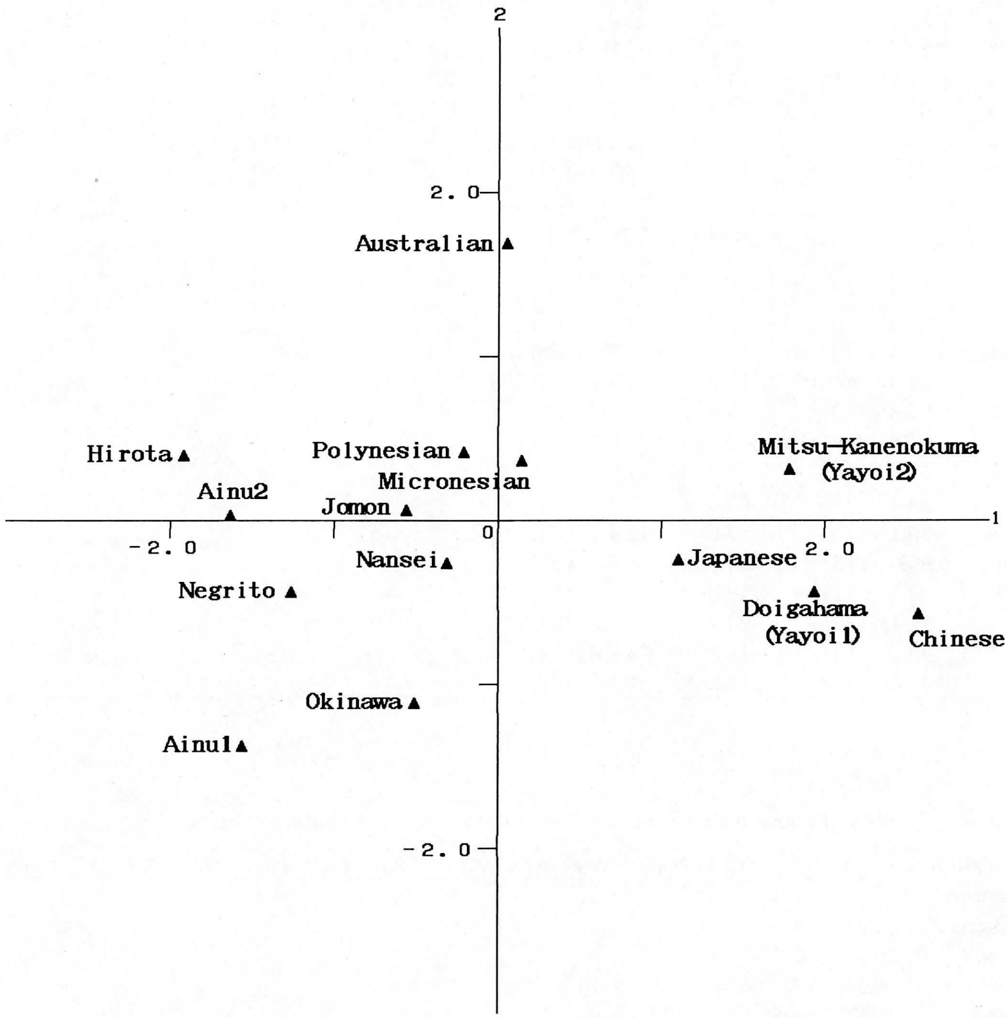


Fig. 1. Two-dimensional expression of multidimensional scaling applied to B-square distances based on nine discrete crown traits, in which 85% of total variance is expressed.

To address the origin and affinities of the Jomon and related populations in Japan, or indigenous Japanese, the attention should be turned to the events associated with the peopling of Southeast Asia and the Pacific.

Table 5. Distance matrix transformed from Q-mode correlation coefficients between each population.

Population	Daj	Neg	Ain	Aog	Tok	Jom	Gua	Oah	Mar	Mel
Dajak	—									
Negrito	0.987	—								
Ainu	1.221	1.423	—							
Aogashima	1.044	0.585	0.595	—						
Tokunoshima	1.322	0.690	0.575	0.343	—					
Jomon	1.223	0.873	0.747	0.722	1.108	—				
Guam	1.320	1.155	0.922	1.274	1.075	1.366	—			
Oahu	1.229	1.159	1.221	1.442	1.063	1.028	0.792	—		
Marquesas	1.470	1.038	1.480	1.596	1.320	1.153	0.531	0.291	—	
Melanesian	1.069	1.401	1.341	0.158	1.452	0.323	1.110	1.210	0.824	—

Table 5 shows a Q-mode correlation matrix computed from mesiodistal crown diameters (cited from T. Hanihara, in press), and figure 2 is a dendrogram obtained from the matrix. Along with Ainu and Jomon, some geographically isolated groups are included in the same cluster with Southeast Asians, Negritos and Dajaks. The Pacific cluster is separated into the Melanesian and Polynesian-Micronesian components. Figure. 3 is a scattergram of the same populations in Fig. 2 provided by multidimensional scaling method. Here again, the two major clusters are evidently recognized. It is worth noting that the scattering pattern of the samples is almost in agreement with their geographic distribution pattern.

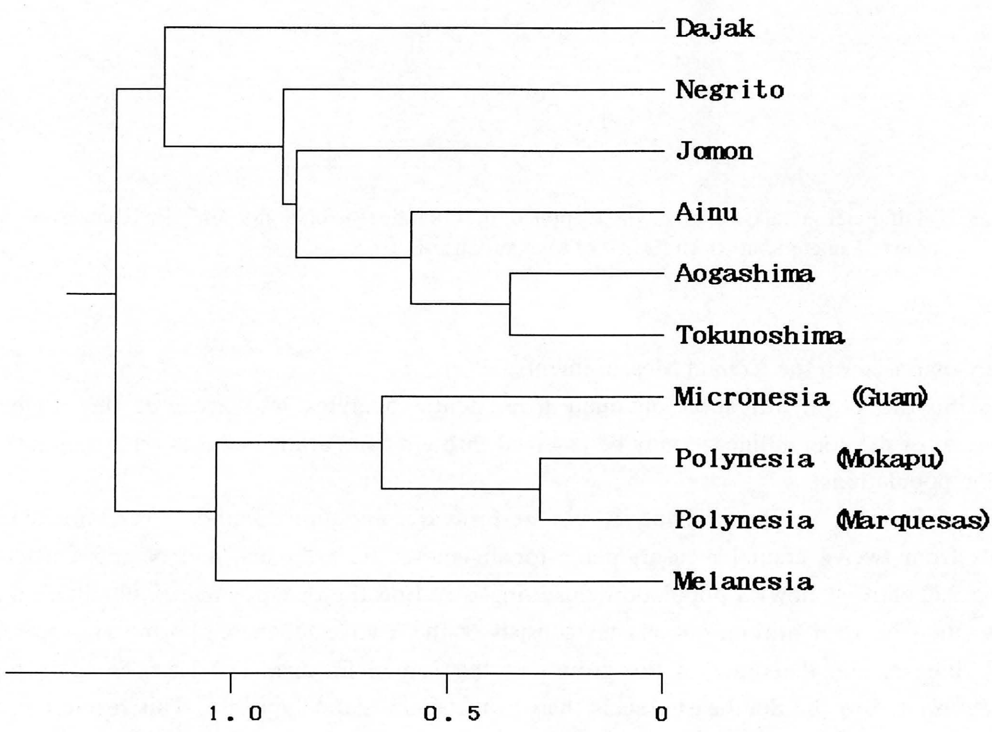


Fig. 2. Clustering by group average method. Distance matrix transformed from Q-mode correlation coefficients based on mesiodistal (M-D) crown diameters.

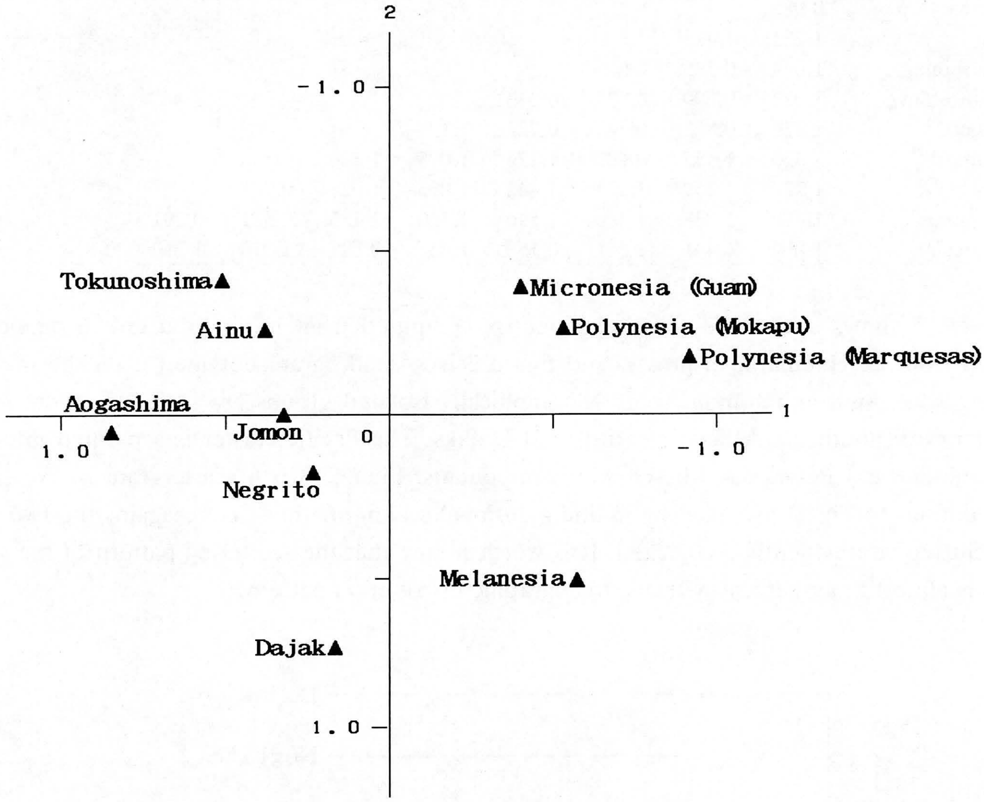


Fig. 3. Multidimensional scaling method applied to Q-mode correlation coefficients based on M-D crown diameters, in which 71.2% of total variance is expressed.

Analyses Based on the Cranial Measurements

Taking the racial affiliation obtained from dental analyses into account, the origin of Japanese of the Jomon lineage may be assessed through comparative studies on Asian and the Pacific populations.

To begin with, a distance analysis was performed computing Q-mode correlation coefficients from twelve cranial measurements for Japanese, East Asians, and Negritos listed in Table 2. Figure 4 shows a population clustering based on the distance matrix obtained. Similar to the case of dentition, one cluster consists of the Yayoi, Japanese, Formosans, Koreans and Chinese, and the other of the groups of the Jomon lineage. The latter is again more closely related to the Southeast Asians than to the main-island Japanese. This result suggests the separation of indigenous Japanese from the modern typical East Asian populations such as Chinese, Koreans, main-island Japanese and other Northeast Asians.

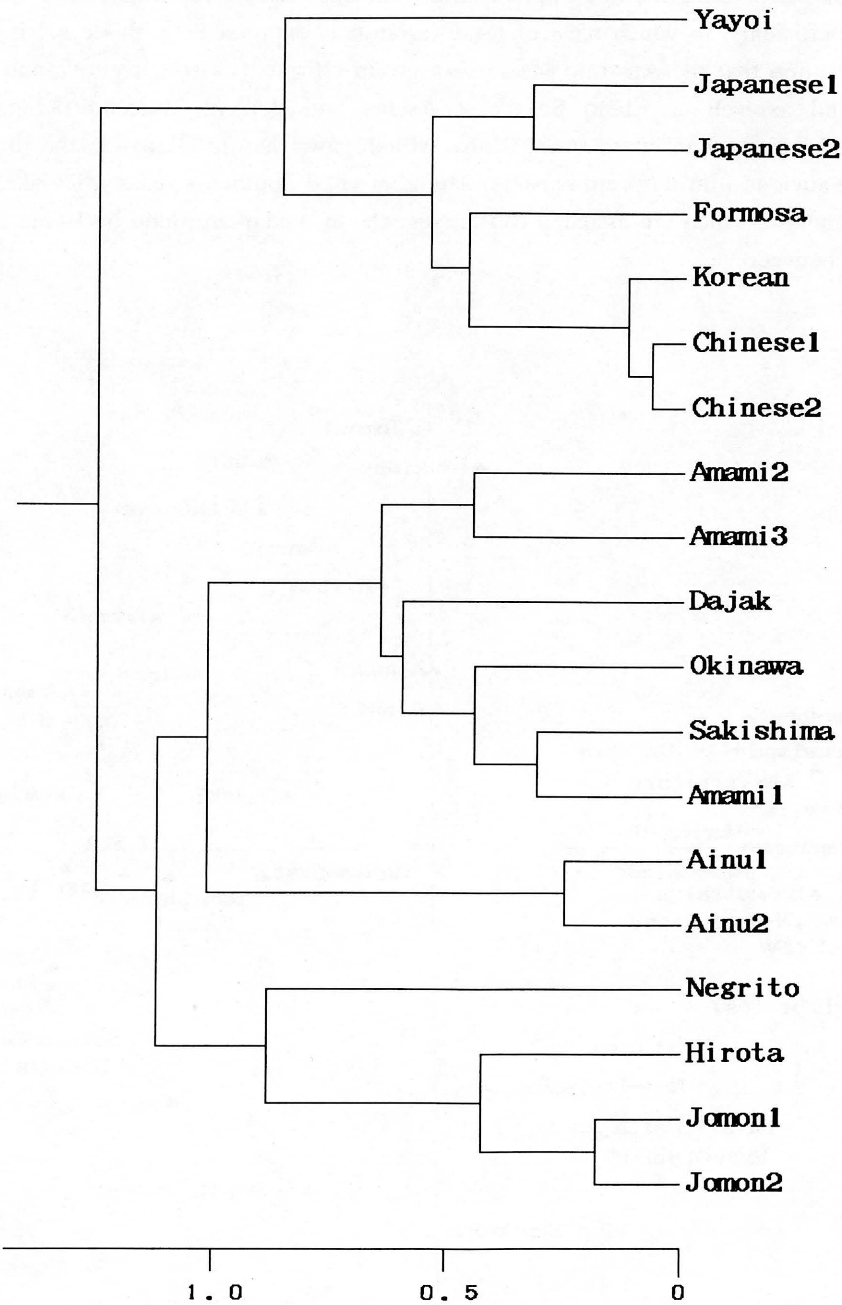


Fig. 4. Clustering by group average method. Based on the Q-mode correlation coefficients applied to the dental measurements.

For the second step of analysis, the indigenous Japanese in the past and present are compared with the major geographic populations in western Oceania and Southeast Asia.

In this analysis, measurements M45 and M51 were omitted. Figure 5 displays the result of multidimensional scaling method applied on the distance matrix computed from Q-mode correlation coefficients, in which 65% of total variance is expressed. In this case, it draws our special attention that the Australo-Melanesian group affirms its distinctiveness, and the group of mainland as well as island Southeast Asians and that of indigenous Japanese, the Paleolithic Liukiang man in southeast China, Minatogawa man in Okinawa, and the Neolithic Jomon are divided into different clusters. The aboriginal Southeast Asians, Dajaks, Negritos, and Andamanese which are assigned to the Negritos in Andaman island by Bonin (1931), are plotted in between.

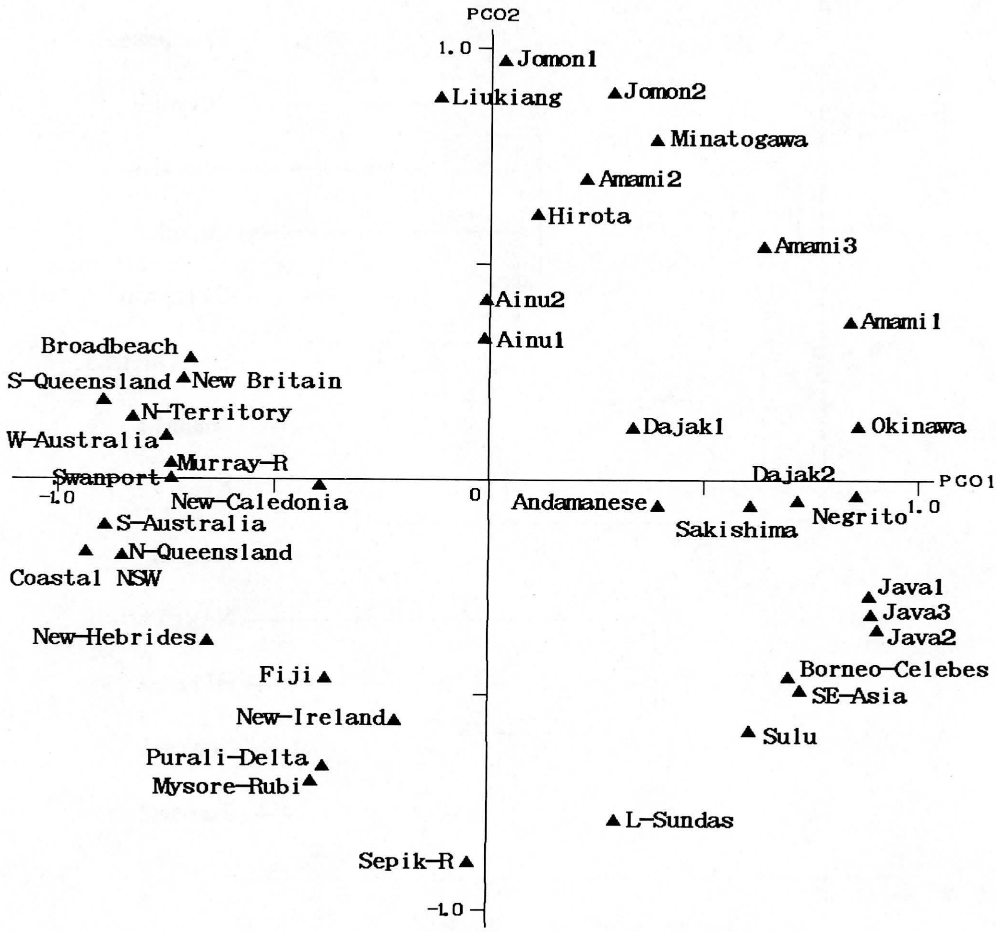


Fig. 5. Two-dimensional expression of multidimensional scaling method applied to Q-mode correlation coefficients based on 10 dental measurements.

Discussion

The results of the present study allow some tentative conclusion regarding the biological relationships and possible origins and affinities of the indigenous Japanese of the Jomon lineage.

Dental evidence presented in this study provides further insight into the association of the aboriginal Southeast Asians with Jomon. The cranial evidence also shows a close relationship between prehistoric as well as contemporary indigenous Japanese and Southeast Asians. The aboriginal Southeast Asians share the similar characteristics with the two geographic groups. Based on the findings, the possible relationship among the Jomon lineage and Southeast Asians will be discussed here.

Negrito Problem

In a past few decades, many anthropologists have looked for signs of the related population of Australian Aborigines as well as Melanesians, and considered people like Negritos as being one of the possible representatives of them (Birdsell, 1947, 1977; Garn, 1961; Coon, 1962; Jacob, 1967; Howells, 1976; Brues, 1977; Kennedy, 1977; Glinka, 1981; Bellwood, 1985).

In the tropical rain-forest of Sundaland in the late Pleistocene, the Proto-Australoids may have evolved into the indigenous inhabitants of Southeast Asians who have acquired a phenotypic specialization such as small size and gracilization. Omoto (1984) first pointed out closer relationship between Negritos and adjacent Southeast Asians than that between the former and Australian Aborigines. Dental and cranial morphology also suggests the consistent association of Negritos with Southeast Asians (Hanihara, T., 1989c, 1990a, b, c, in press).

An orthodox view suggests that the facial and cranial gracilization of the Indo-Malaysian populations and mainland Southeast Asians may have taken place as a result of local selective pressure and the Holocene gene flow from more northern Chinese (Coon, 1962; Bellwood, 1985; and others). The aboriginal Southeast Asians who were not affected by the Chinese admixture have been thought, therefore, to be the remnants of the population showing physical affinities to Australo-Melanesian group in Southeast Asia. On the contrary, Turner (1987, 1990) and Pietrusewsky (1988) proposed a local evolution model of recent Southeast Asians based on the dental and craniofacial morphology. Both dental and cranial evidence presented here supports the view that the aboriginal Southeast Asians, or Negritos, are not a racial stock closely related to the Australo-Melanesians but a lineage leading to Jomon and the present-day Southeast Asians. The similar dental pattern of Negritos and Jomon, or 'sundadont' dental pattern, provides further evidence favoring a local evolution hypotheses for the origin of sundadonty proposed by Turner (1987, 1990).

Jomon Problem

In the previous section, I pointed out the odontological relationships between Jomon and Southeast Asians. Almost the same relationships were also obtained from cranial morphology. Since the biological assessment of Southeast Asians and Jomon based on the dental and cranial evidence was discussed in detail elsewhere (Hanihara, T., in press), the discussion will be summarized in the present paper.

According to Omoto (1984), the Aeta tribe of the Philippine Negritos was influenced by the hunter-gatherers who intruded from the Asian mainland some 10,000-20,000 years B. P. If it is true, a morphological cline shown in Fig. 2 may help to elucidate the affinities of indigenous Japanese from the context of racial formation in East Asia and Pacific.

In dealing with this procedure, a 'stepping stone model' was applied. This model examines the clinal form with respect to the relationships between biological correlation coefficients and the geographic distance between two colonies (Kimura and Weiss, 1964). In applying this model, the following some hypotheses were adopted. (1) Dajaks are one of the remnants of the aboriginal Southeast Asians (2) the clinal center is Pontianak of Borneo where the specimens of Dajaks were collected; (3) the geographic distance from Dajaks to each population was roughly estimated employing the linear distance between Pontianak and the following sampling sites: Bataan Peninsula of Luzon (see Omoto, 1984) for Negritos; Tokyo for Jomon; Hidaka of Hokkaido for Ainu; center of Tokunoshima island for Tokunoshima; and center of Aogashima island for Aogashima.

A simple simulative study given in Fig. 6 shows that the Q-mode correlation coefficients between Dajaks and the other populations decrease approximately in exponential form with distance. This roughly corresponds to the two-dimensional case of stepping stone model, which can represent a population on a plane and cover the most important cases in nature (Kimura and Weiss, 1964). The model applied in this study is still immature. Some essential estimates such as the rate of microevolution from the Neolithic to modern times, migration rate, etc. were omitted because no reliable information was available. Nevertheless, the result seems to show rough estimates to guess the affinities of the population of the Jomon lineage.

The gradual change of the phenotypic pattern in Fig. 6 suggests that Southeast Asians with lesser admixture with Chinese, or aboriginal Southeast Asians, provide at least part of the morphological background of Jomon (see Hanihara, T., in press, for detailed discussion of this figure).

The simulation just described seems to suggest, in combination with the result obtained from a cranial analysis, that the ancestral Jomon population migrated to the Japanese Archipelago using the course of Nansei Islands as one of migration routes.

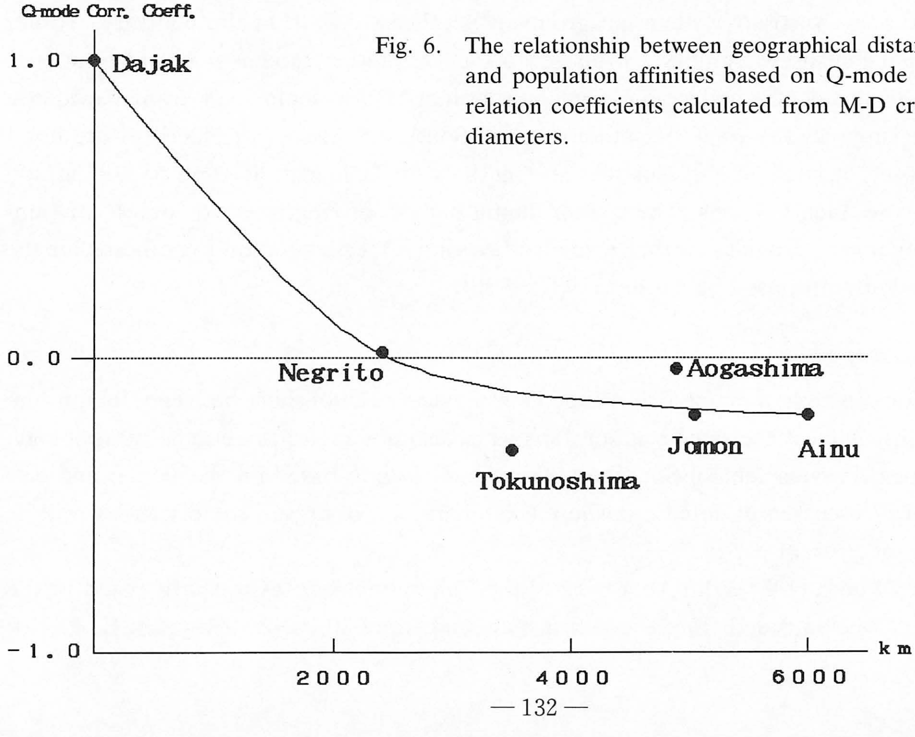


Fig. 6. The relationship between geographical distances and population affinities based on Q-mode correlation coefficients calculated from M-D crown diameters.

Summary and Conclusion

The origin and affinities of the Japan's Neolithic Jomon population and their lineage are controversial. In the present study, dental and cranial data obtained from the Jomon population were compared with those of four major geographical groups recognized as Australo-Melanesians, Micronesians, Polynesians and East Asians. The results obtained reveal that the Jomon population and their lineage such as Ainu and the Nansei islanders show closer affinities to the Southeast Asians than to the Aeneolithic Yayoi populations and modern main-island Japanese. The aboriginal Southeast Asians may represent at least part of the morphological background of the Jomon lineage.

The present study also revealed a crown pattern which is unique to the Australian Aborigines. This pattern is characterized by the higher frequencies of crown traits which appear frequently in the individuals of the Upper Pleistocene or earlier ages. It is probable, therefore, that this pattern represents a microevolutionary step prior to the emergence of the sundadont and sinodont patterns. If so, it may be termed 'proto-sundadont' dental pattern applying Turner's way of terminology. This issue will be discussed in detail in the separate paper.

References

Balakrishnan, V. and Sanghvi, L. D. (1968): Distance between populations on the basis of attribute data. *Biometrics*, 24: 859-865.

Bellwood, P. (1985): *Prehistory of the Indo-Malaysian Archipelago.* Academic Press.

Birdsell, J. B. (1949): The racial origin of the extinct Tasmanians. *Rec. Queen Vic. Mus. II*, 3: 105-122.

Birdsell, J. B. (1977): The recalibration of a paradigm for the first peopling of greater Australia. In Allen, J., J. Golson and R. Jones (eds.): *Sunda and Sahul: Prehistoric Studies in Southeast Asia, Melanesia and Australia.* London, Academic Press, pp. 113-167.

Bonin, G. von (1931): Beitrag zur Kraniologie von Ost-Asian. *Biometrika*, 23: 52-95.

Bowler J. M. (1976): Recent developments in reconstructing late Quaternary environments in Australia. In Kirk, R. L. and A. G. Thorne (eds.): *The Origin of the Australians.* Canberra, Australian Institute of Aboriginal Studies, pp. 55-77.

Brace, C. L. and Hinton, R. J. (1981): Oceanic tooth-size variation as reflection of biological and cultural mixing. *Curr. Anthropol.* 22: 549-569.

Brace, C. L. and Nagai, M. (1982): Japanese tooth size: Past and present. *Am. J. Phys. Anthropol.* 59: 399-411.

Brace, C. L., Brace, M. L., and Leonard, W. R. (1989): Reflections on the face of Japan: A multivariate craniofacial and odontometric perspective. *Am. J. Phys. Anthropol.* 78: 93-113.

Brues, A. M. (1977): *People and Race.* The Macmillan Series in Physical Anthropology, New York, Macmillan Publishing Co.

Chappell, J. M. A. (1976): Aspects of late Quaternary palaeogeography of the Australian-east Indonesian region. In Kirk, R. L. and A. G. Thorne (eds.): *Canberra, Australian Institute of Aboriginal Studies*, pp. 11-22.

Coon, C. S. (1962): *The Origin of Races.* New York, Alfred A. Knopf.

Dodo, Y. and Ishida, H. (1988): Nonmetric analyses of the Doigahama crania of the Aeneolithic Yayoi period in western Japan. *Establishment of Japanese People and their Culture*, 1. Festschrift Professor Masafumi Nagai in Commemoration of his Retirement, Tokyo, Rokko Shuppan, pp. 127-142. (In Japanese with English summary.)

Dodo, Y. and Ishida, H. (1990): Population history of Japan as viewed from cranial nonmetric variation. J. *Anthropol. Soc. Nippon*, 98: 269-287.

Garn, S. M. (1961): *Human Races.* Charles C. Thomas Publisher.

Glinka, J. (1981): Racial history of Indonesia. In Schwidetzky, I. (ed.): *Rassengeschichte der Menschheit* 8. München/Wien, R. Oldenbourg, pp. 79-113.

Hanihara, K. (1985): Geographic variation of modern Japanese crania and its relationship to the origin of Japanese. *Homo*, 36: 1-10.

Hanihara, K. (1987): Estimation of the number of early migrants to Japan: A simulative study. *J. Anthropol. Soc. Nippon*, 95: 391-403.

Hanihara, K. (1991): Dual structure model for the population history of Japanese. *Japan Review*, 2: 1-33.

Hanihara, K., Kouchi, M., and Koizumi, K. (1982): A Preliminary analysis of geographical variations in the male Japanese crania. *J. Anthropol. Soc. Nippon*, 90 (Suppl.): 139-152.

Hanihara, T. (1989a): Comparative studies of dental characteristics in the Aogashima Islanders. *J. Anthropol. Soc. Nippon*, 97: 9-22.

Hanihara, T. (1989b): Comparative studies of geographically isolated populations in Japan based on dental measurements. *J. Anthropol. Soc. Nippon*, 97: 95-107.

Hanihara, T. (1989c): Affinities of the Philippine Negritos as viewed from dental characters: A preliminary reports. *J. Anthropol. Soc. Nippon*, 97: 327-339.

Hanihara, T. (1990a): Affinities of the Philippine Negritos with modern Japanese and the Pacific populations based on dental measurements: The basic populations in East Asia, I. *J. Anthropol. Soc. Nippon*, 98: 13-27.

Hanihara, T. (1990b): Dental anthropological evidence of affinities among the Oceania and the Pan-Pacific populations: The basic populations in East Asia, II. *J. Anthropol. Soc. Nippon*, 98: 233-246.

Hanihara, T. (1990c): Studies on the affinities of Sakhalin Ainu based on dental characters: The basic populations in East Asia, III. *J. Anthropol. Soc. Nippon*, 98: 425-437.

Hanihara, T. (n.d.): Dental and cranial affinities among populations of East Asia and the Pacific: The basic populations in East Asia, IV. *Am. J. Phys. Anthropol.* (In press).

Harris, E. F., Turner, C. G. II and Underwood, J. H. (1975): Dental morphology of living Yap islanders, Micronesia. III. Peopling of the Pacific. *Archeol. Phys. Anthropol. in Oceania*, 10: 218-234.

Howells, W. W. (1973): *Cranial Variation in Man. A study by multivariate analysis of patterns of differences among recent human populations.* Pap. Peabody Mus. Archaeol. Ethnol., Harvard Univ.

Howells, W. W. (1976): Physical variation and history in Melanesia and Australia. *Am. J. Phys. Anthropol.*, 45: 641-650.

Jacob, T. (1967): Racial identification of Bronze age human dentitions from Bali, Indonesia. *J. Dent. Res.*, 46: 903-910.

Kennedy, K. A. R. (1979): The deep skull of Niah: An assessment of twenty years of speculation concerning its evolutionary significance. *Asian Perspectives*, 20: 32-50.

Kimura, M. and Weiss, G. H. (1964): The stepping stone model of population structure and the decrease of genetic correlation with distance. *Genetics*, 49: 561-576.

Kirch, P. V., Swindler, D. R. and Turner, C. G. II (1989): Human skeletal and dental remains from Lapita sites (1600-500 B. C.) in the Mussau Islands, Melanesia. *Am. J. Phys. Anthropol.*, 79: 63-76.

Macintosh, N. W. G. and Larnach, S. L. (1976): Aboriginal affinities looked at in world context. In Kirk, R. L. and A. G. Thorne (eds): *The Origin of the Australians.* Canberra, Australian Institute of Aboriginal Studies, pp. 113-126.

Kouchi, M. (1983): *Geographic variation in modern Japanese somatometric data and its interpretation. Univ.* Mus., Univ. Tokyo Bull., No. 22.

Martin, R., and Saller, K. (1957): *Lehrbuch der Anthropologie.* Dritte Aufl., Bl. I. Gustav Fischer Verg. Stuttgart.

Mizoguchi, Y. (1988): Affinities of the protohistoric Kofun people of Japan with pre- and protohistoric Asian populations. *J. Anthropol. Soc. Nippon*, 96: 71-109.

Nakahashi, T. (1989): The problem of immigrants in the prehistory of Japan from the physical anthropological viewpoint. In Nishiya, T. (ed.): *Prehistoric Korea and Japan.* Meicho-Shuppan Co., pp 117-174. (In Japanese.)

Omoto, K. (1984): The Negritos: Genetic origins and microevolution. *Acta Anthropogenetica*, 8: 137-147.

Omoto, K. (1987): Human migration in Southwest Japan as viewed from the gene distribution. *Kikan Jinruigaku*, 18: 202-219. (In Japanese.)

Pietrusewsky, M. (1984) Metric and non-metric cranial variation in Australian Aboriginal populations compared with populations from the Pacific and Asia. *Occasional Papers in Human Biology, 3.* Australian Institute of Aboriginal Studies, Canberra.

Pietrusewsky, M. (1988): Multivariate comparisons of recently excavated Neolithic human crania from the Socialist Republic of Vietnam. *Internat. J. Anthropol.*,3: 267-283.

Riesenfeld, A. (1956): Shovel-shaped incisor and a few other dental features among native peoples of the Pacific. *Am. J. Phys. Anthropol.*, 14: 505-521.

Simmons, R. T. (1956): A report on blood group genetical surveys in eastern Asia, Indonesia, Melanesia, Micronesia, Polynesia and Australia in the study of man. *Anthropos*, 51: 500-512.

Simmons, R. T. (1962): Blood group genes in Polynesians and comparisons with other Pacific peoples. *Oceania*, 32: 198-210.

Suzuki, H. (1982): Skulls of the Minatogawa man. In Suzuki, H. and K. Hanihara (eds.): *The Minatogawa Man. The Upper Pleistocene Man from the Island of Okinawa.* The University Museum, The University of Tokyo, Bulletin No. 19, pp. 7-49.

Thorne, A. G. (1976): Morphological contrasts in Pleistocene Australians. In Kirk, R. L. and A. G. Thorne (eds.): *The origin of the Australians.* Canberra, Australian Institute of Aboriginal Studies, pp. 95-112.

Turner, C. G. II (1976): Dental evidence on the origins of the Ainu and Japanese. *Science*, 193: 911-913.

Turner, C. G. II (1979): Dental anthropological indications of agriculture among the Jomon of central Japan. *Am. J. Phys. Anthropol*,. 51: 619-636.

Turner, C. G. II (1987): Late Pleistocene and Holocene population history of East Asia based on dental variation. *Am. J. Phys. Anthropol.,* 73: 305-321.
Turner, C. G. II (1989): Teeth and prehistory in Asia. *Scientific American*, February, pp. 70-77.
Turner, C. G. II (1990): Major features of sundadonty and sinodonty, including suggestions about East Asian microevolution, population history and late Pleistocene relationships with Australian Aboriginals. *Am. J. Phys. Anthropol.,* 82: 295-317.
Turner, C. G. II and Swindler, D. R. (1978): The dentition of New Britain west Nakanai Melanesians. VIII. Peopling of the Pacific. Am. *J. Phys. Anthropol*., 49: 361-372.
Woo, Ju-K. (1959) Human fossils found in Liukiang, Kwsangsi, China. Vertebrata Palasiatica, 3: 109-123.
Yamaguchi, B. (1982): A review of the osteological characteristics of the Jomon population in prehistoric Japan. *J. Anthropol. Soc. Nippon,* 90 (Suppl.): 77-90.
Yamaguchi, B. (1985): The incidence of minor non-metric cranial variants in the protohistoric human remains from eastern Japan. *Bull. Nat. Sci. Mus. Tokyo,* Ser. D, 11: 13-24.

抄録

歯及び頭骨形態からみた東アジア、太平洋地域集団の類縁関係

埴原恒彦

日本人の起源に関する研究においては、縄文人の系統を明らかにすることがその根幹をなす。本研究では、このような視点から縄文人と東アジア、太平洋地域に分布する様々な集団の類縁関係を分析した。具体的な比較集団として、オーストラリア原住民、メラネシア、ミクロネシア、ポリネシア集団、東南アジア諸集団、中国、朝鮮、日本列島の各集団（本州日本人、アイヌ、青ヶ島島民、南西諸島民、弥生人）等を用い、これら諸集団間の歯及び頭骨の形態学的変異から縄文人の起源についての考察を試みた。

分析結果から、まず、オーストラリア原住民、メラネシア集団の歯と頭骨形態の特異性が明かである。このことは、彼らが早い時期（4～5万年前）に東南アジアから拡散し、その後、独自の進化を遂げ現在に至っていることを裏付けている。一方、このいわゆるオーストラロメラネシア集団以外に、東アジア、太平洋地域では大きく三つのクラスターが認められる。一つは中国人、朝鮮人、本州日本人を含み、このクラスターに渡来系とされる弥生人が含まれる。他の一つは東南アジア諸集団とアイヌ、青ヶ島島民、南西諸島民からなり、このクラスターに縄文人、港川人、柳江人が含まれる。第三のクラスターはミクロネシア人、ポリネシア人からなる。これらの結果は、現代日本人の起源に関しては、その“二重構造仮説”とよく一致しているに対して（詳しくは埴原和郎の稿を参照）、最近提唱されている、太平洋民族の縄文人起源説に関しては、否定的である。また、縄文人が、港川人、柳江人の系統を受け継ぎ、その起源を東南アジアの集団、特にその島嶼部に点在するネグリト、ダヤクといった採集狩猟民の系統に求められる可能性を示している。

ネグリト、ダヤクは、一般にプロトマレーと総称され、東南アジア地域に現存する最古の集団とされている。現在の東南アジア集団の大多数は、主に考古学的、民族学的根拠から、新石器時代から、金属器時代にかけて中国から南下してきた集団とされ、そこの先住民であったオーストラロイド系集団を吸収していったと考えられている。また、このオーストラロイ

ド系集団は、新石器時代まで東南アジアの島嶼部から大陸部に至るまで優勢であったと考えられ、多くの人類学者、考古学者は、ネグリトをこの北からの集団の進出による混血を免れた最古層集団、すなわちオーストラロイド系と考えている。しかし、少なくとも歯と頭骨の形態からはこの仮説は支持されず、むしろ、ネグリトは現在の東南アジア諸集団の原型と考えられる。このことは、同時に、現在の東南アジア集団の成立についてのいわゆる“人種置換説”を再考する必要性をも示唆しているものと思われる。

縄文人の系統に関しては、今日まで漠然と東南アジア集団との類似性が指摘されていたが、本分析結果から、前記の通り、彼らは東南アジア諸集団、特に島嶼部に点在するプロトマレー系集団に形態学的には類似していることが指摘できる。このプロトマレー集団は、後期更新世にスンダランドの熱帯降雨林という環境下で進化してきた集団と考えられているが、彼らの一部は、おそらく、後期更新世から完新世にかけて今は水没してしまった東アジアの大陸棚づたいに北上していったのではないか。そして、そのような集団の中に、縄文人の系統を求め得るのではないかと考えられる。さらに、彼らの日本列島への北上ルートの一つとして、南西諸島を無視することはできないであろう。また、前記の太平洋民族（ミクロネシア人、ポリネシア人）の縄文人起源説に関しては、この両集団の直接的関係を考えるよりも、むしろ、彼らの祖先集団の共通性－おそらく東南アジア、特にその島嶼部の集団－を考察すべきであろう。

歯冠の非計測的形質については、今回対象とした集団は、C. G. ターナーのスンダ型歯形質（sundadont)、中国型歯形質（sinodont）の分類と矛盾するものではないが、オーストラリア原住民の歯冠形質に関しては、多少ともその独自性がみられた。すなわち、この集団には更新世の化石人類にしばしば見られる形質が比較的高頻度に出現する。この特徴は、より単純化したスンダ型歯形質の特徴とは相反するものである。このような歯冠の形質的特徴をここでは仮に“原スンダ型歯形質（proto-sundadont)”と呼ぶことにする。この原スンダ型歯形質はおそらくスンダ型形質よりも古い、更新世人類の特徴であった可能性が考えられるが、このことについてはさらに検討を重ねなければならない。